Measurement of prompt photon in sqrt(s)=200GeV pp collisions

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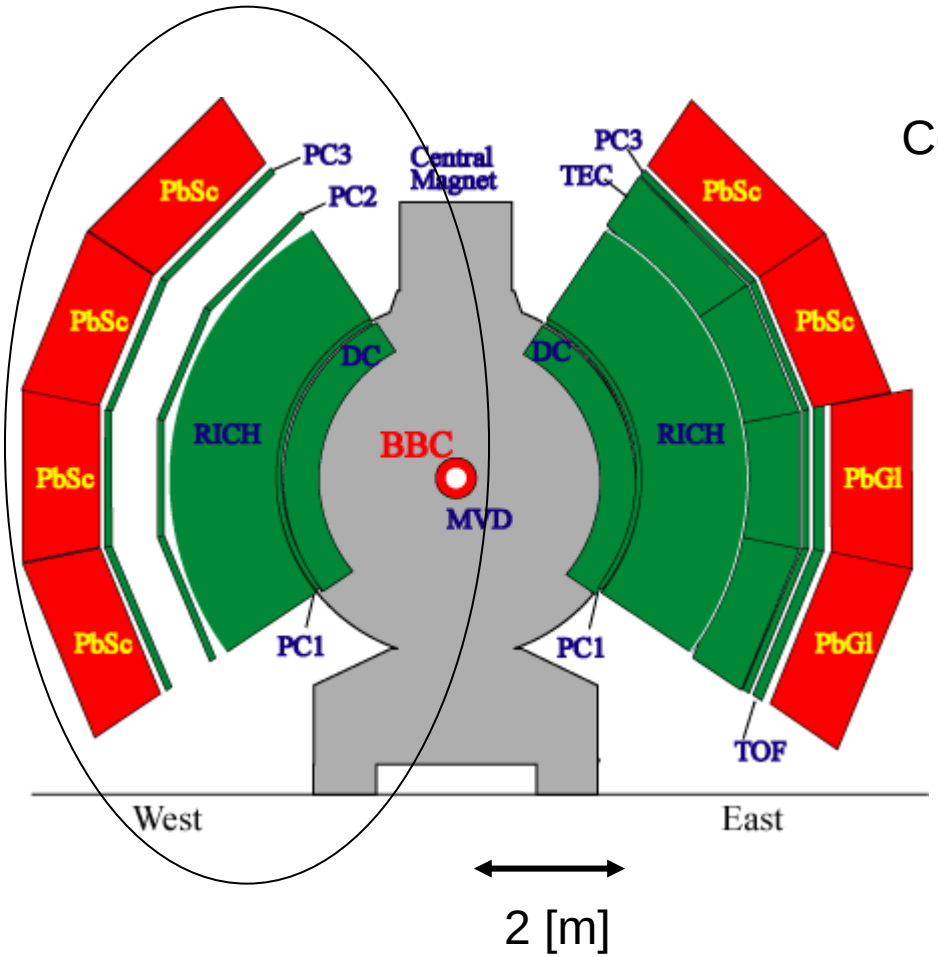
Motivation

- Physics meaning of prompt photon
  - Is a good probe of parton structure in proton.
  - One of simple process at hadron collisions.

- Why prompt photon at RHIC?
  - A reference for QGP search
  - A baseline for measurement of gluon spin
  - RHIC provide the highest energy as proton-proton collisions in the world.

PHENIX detector



Central arm (west)

Rapidity

$|y|<0.35$

EMCal with good resolution (~10*10mrad^2)

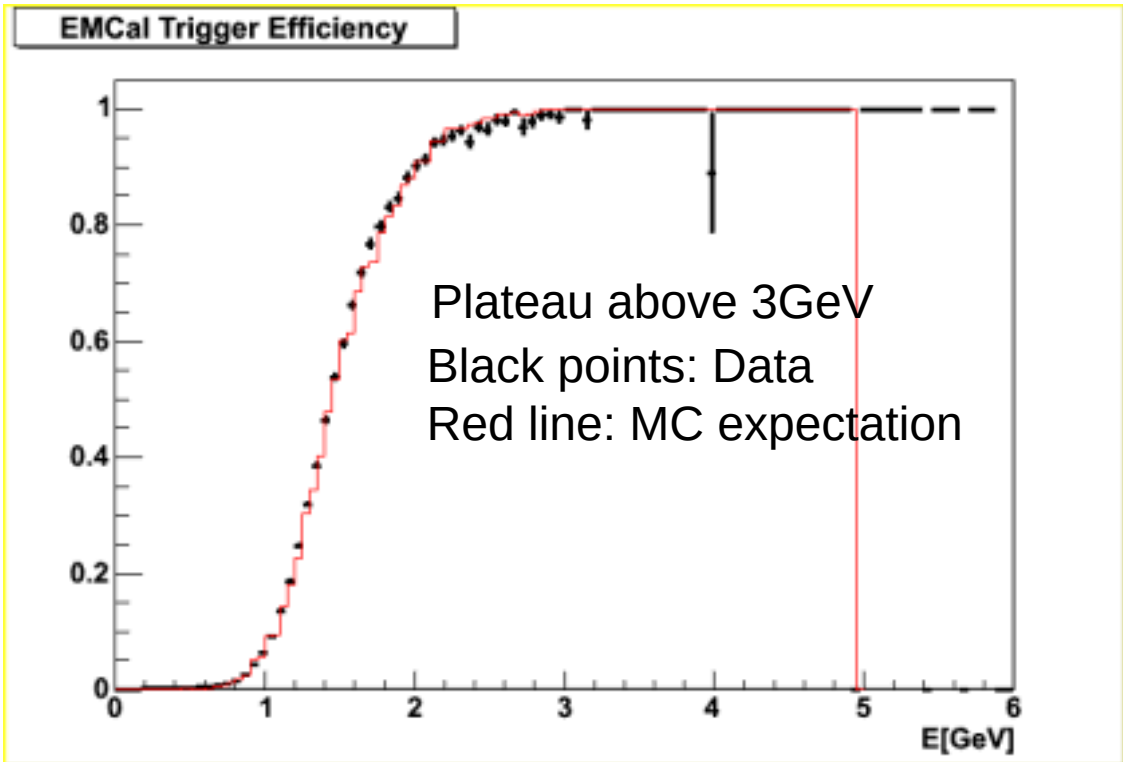
DC for charged hadron veto

Beam-beam counter (BBC) for trigger and vertex determination

Run3 proton proton run

Beam acquisition : From April to May 2003
Beam : 100GeV proton-proton (sqrt(s)=200GeV)

Data were taken with BBC, EMCal trigger
266nb^{-1} (corresponds to 5.450*10^{9} events of BBC trigger)



Experimental difficulty

Contents of EMCal hits

- Photonic decay of hadrons (pi0,eta,etc)
- Hadronic interactions
- Direct photons

Signal to noise ratio is roughly （pT dependent)

- S/N 0.2~1 (pt 5 ~17GeV/c)

To get prompt photon, we will subtract known backgrounds from EMCal clusters.

Improvement of S／N（1）

(1) Non-photon background rejection

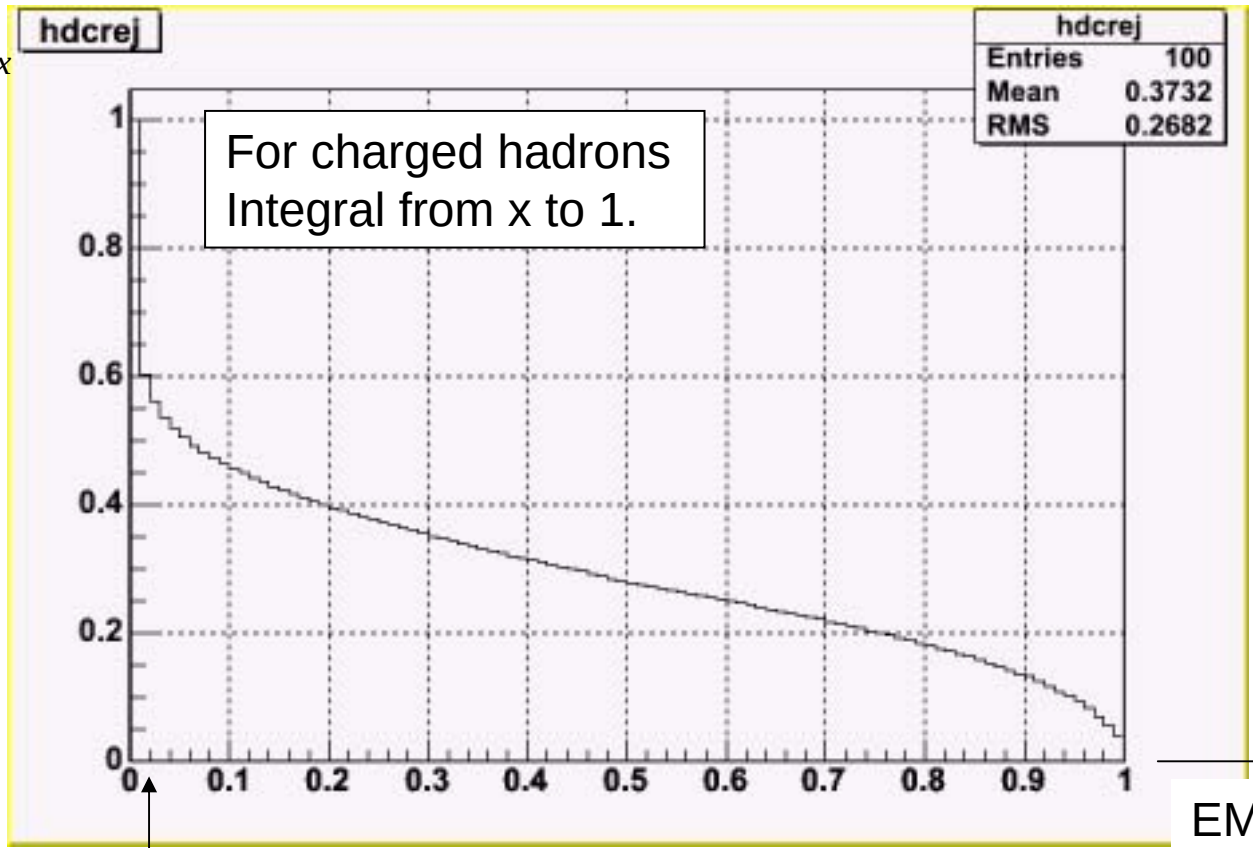
Electromagnetic shower shape requirement
Charged hadron veto using the drift chamber tracks.

(2) Photon background rejection

Pi0 tagging
Other components are calculated based on tagged pi0 (MC).

Pi0 tagging efficiency is essential !!

Electromagnetic shower shape cut



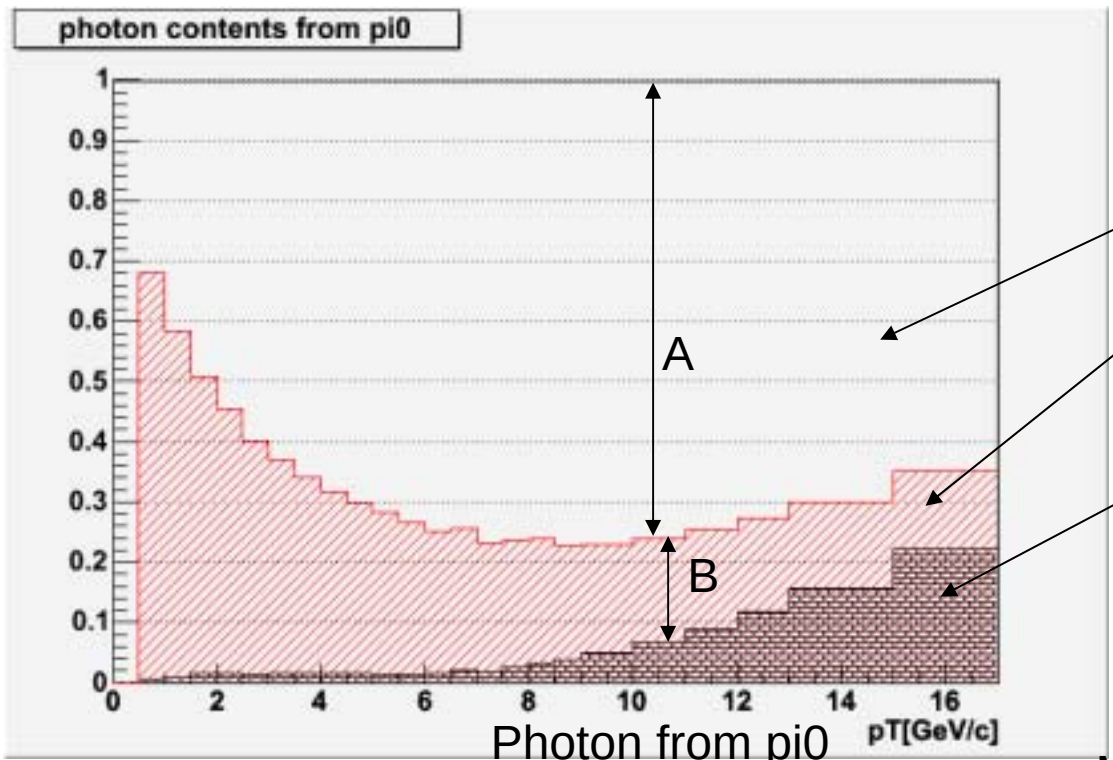
With Prob>0.02 cut
40% of hadronic shower hits are rejected
98% of photons are remained

Pi0 tagging

Reason to fail	Our efforts to recover them
—Out of EMCal Arm →	Assign edges to guard veto region (only for the partner search)
—EMCal bad area →	Careful definition
—Less than the minimum E →	Set E_{min} at 150MeV (as low as possible).
—Photon conversions →	Charged veto with DC tracks, not with a detector in front of the EMCal
—Photon merging →	In our pT region, those are rejected by the EM shower shape cut.

pi0 photon missing ratio (with MC)

Input: pi0 spectra, Energy resolution, Shower size from measurements
The same MC used in pi0 cross section measurement.



Photon from pi0

This figure shows components of photon from pi0.

(A) 2 photons tagged as pi0

(B) 1photon (the partner missing)

Merged photons
(to be discarded by the shower shape cut
And those have almost double energy)

Miss/ tag (=B/A)
40% at 5GeV/c
20% at 10GeV/c

Contributions of eta, omega, etc.

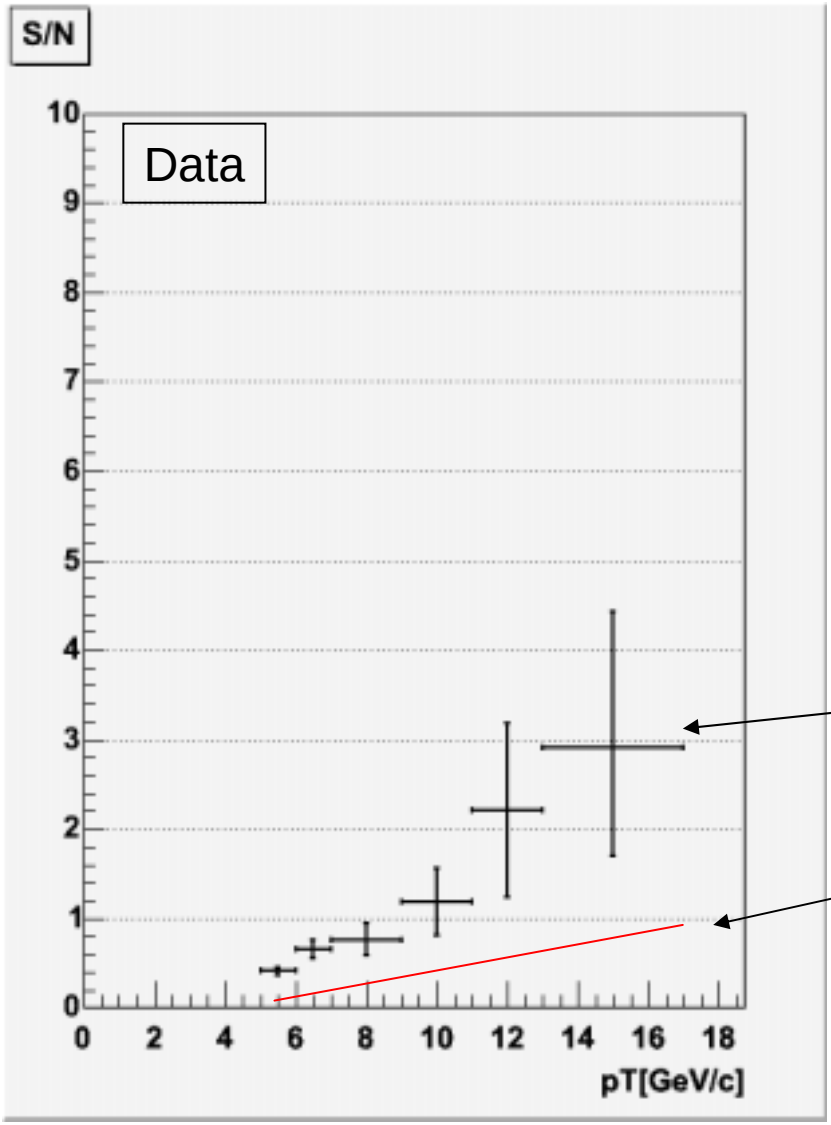
It comes from a product of (production ratio) and (decay branching ratio) to pi0.

- (Eta$\rightarrow 2\gamma$)/(pi0 $\rightarrow 2\gamma$)
  0.45 (=production ratio) * 0.394/0.988 (= Decay branching ratio) = 0.18
- ($\omega \rightarrow \gamma$,pi0)/(pi0 $\rightarrow 2\gamma$)
  0.8 *0.087/0.988 *1/2 = 0.034
- etc

We used the value below with error

(non pi0 hadrons to gamma)/ (pi0 to gamma)
= 0.23+-0.05

Signal to noise ratio



S: signals = all - (pi0, eta contributions)
N: background = (all – signal – pi0tagged)

With pi0 tagging

~ Raw

A big improvement was obtained.

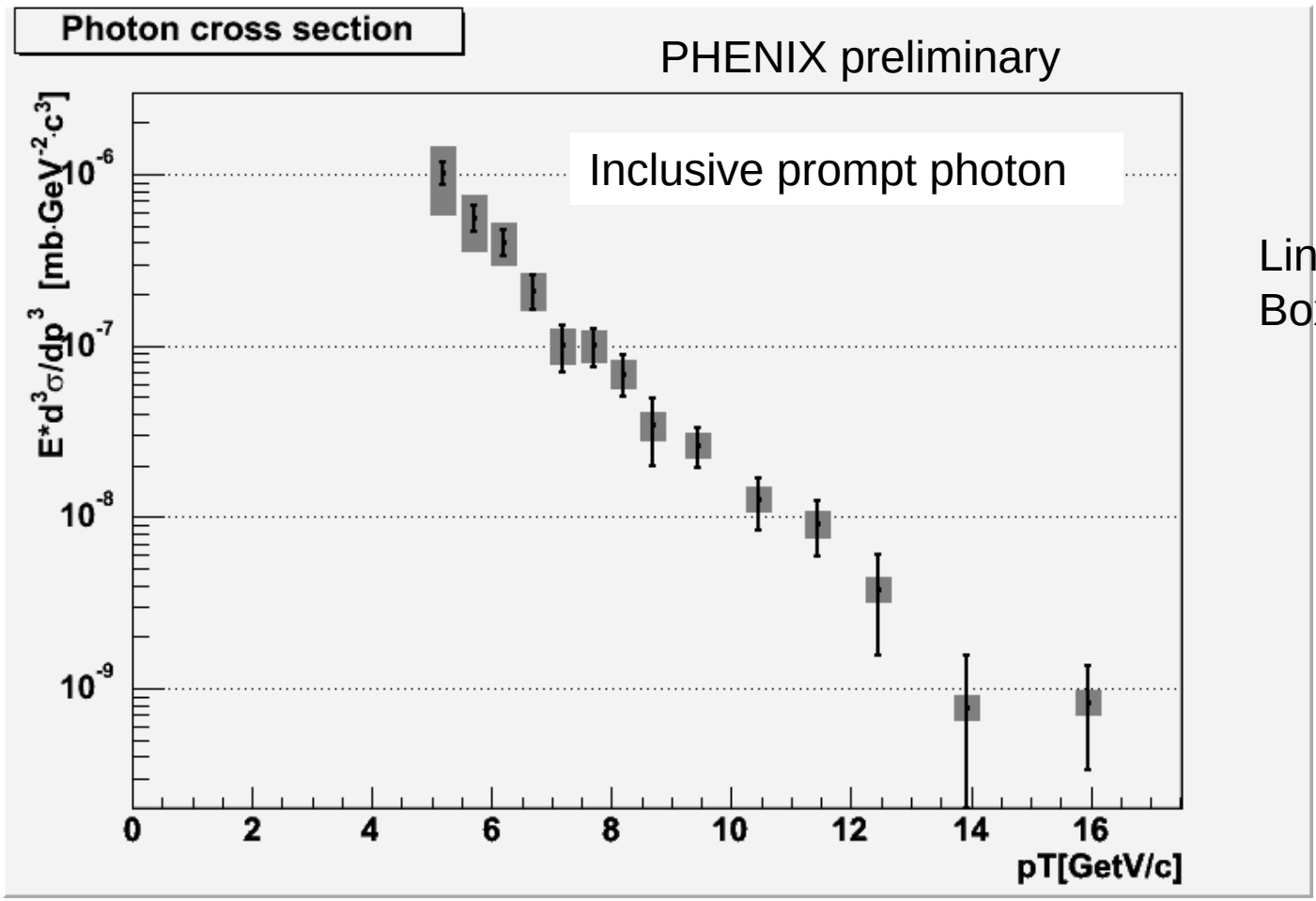
Cross section calculation

Factors

1/Luminosity: 1/266nb^{-1} (=5.450e9 events/20.5mb)
1/bbc_bias: 1/0.785
1/(acceptance+smearing): 1/0.0982
1/(shower shape cut efficiency): 1/0.98
1/(Conversion probability): 1/0.97

Direct photon cross section

This is the plot.



Line: statistical error
Box: systematic error

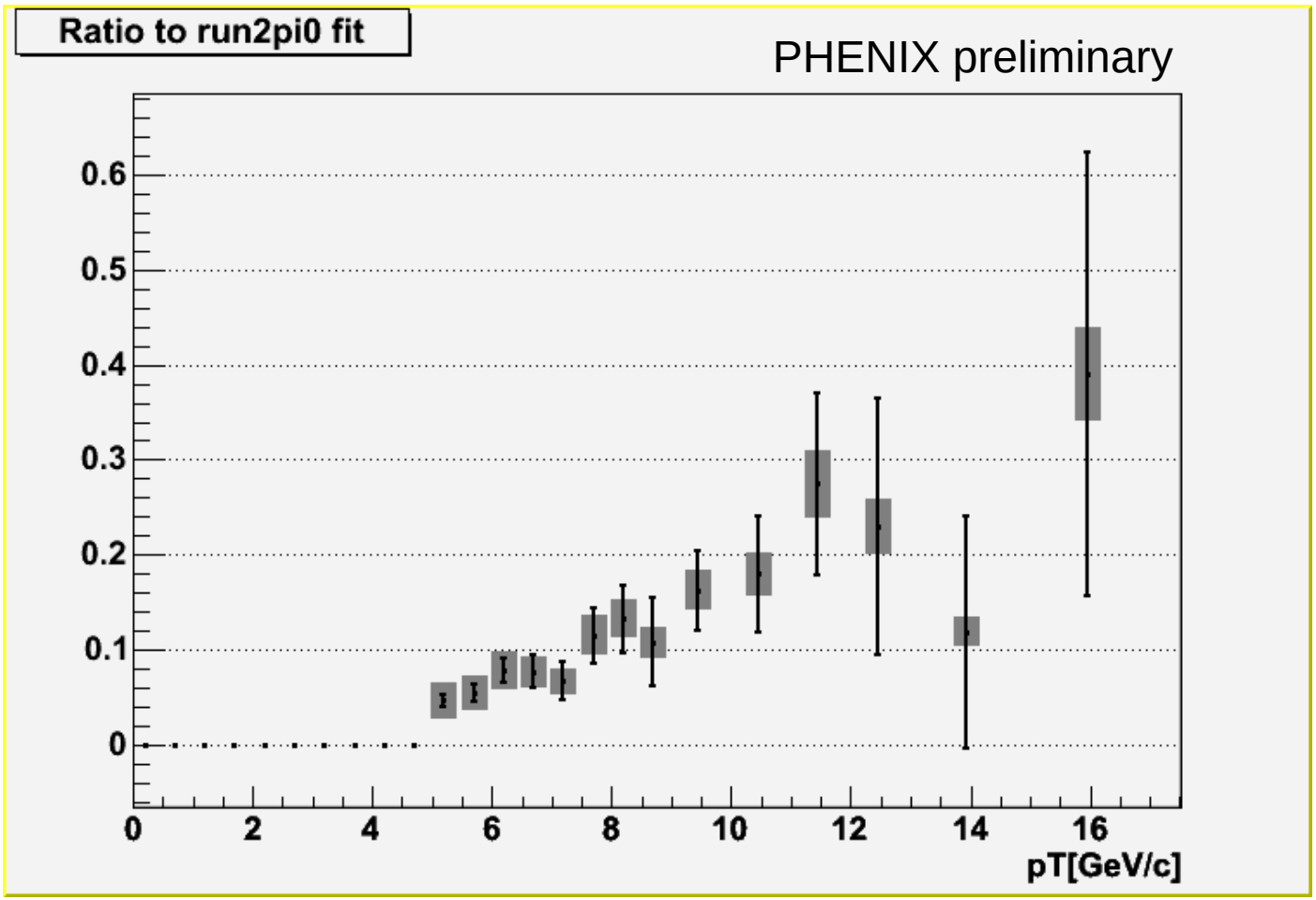
Systematic error sources

	Lowest 5-5.5 [GeV/c]	Highest 15-17 [GeV/c]	
Pi0 photon missing ratio	30%	5	Point to point
Non pi0 contribution	27	6	
Photon acceptance and smearing	10	10	
Photon conversion effect	1	1	
Luminosity measurement	12	12	global
BBC trigger bias	3	3	
Total	43%	18	

Errors on the backgrounds resulted errors on the signal enlarged especially at lower pT region.

Gamma/pi0 ratio

Ratio to pi0 fit function of our measurement in Run2
(Y=20.39*pT^-8.285)



Summary

Pi0 tagging and subtraction method is developed :

- It improves the signal to noise ratio
- We measured prompt photon production cross section (pT>5GeV/c).
- This is the measurement from the highest energy pp collision ever done.

The next speaker (Hisa) will apply an isolation cut to photons. It is expected to enhance the “direct” component of prompt photons.

He will also summarize the comparison of our data with other experiments and NLO pQCD calculations.